Monitoring of European Green Crabs, *Carcinus maenas*, in Humboldt Bay, California
2012 Summary Report

prepared by

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Introduction and Project Background

The European green crab, *Carcinus maenas*, is native to the Atlantic coasts of Europe and is now established from Nova Scotia to New Jersey (Cohen et al., 1995). *C. maenas* is able to successfully establish new populations when introduced outside its natural range. On the west coast of North America, the green crab was first detected in San Francisco Bay in 1989 and the range quickly expanded from San Francisco Bay northward to Bolinas Lagoon, Drakes Estero, Tomales Bay, Bodega Bay and Humboldt Bay and into Oregon, Washington and British Columbia estuaries. Based on genetic studies, it is known the green crabs that established in California came from the eastern United States (Geller et al., 1997).

*C. maenas* can withstand a wide range of environmental conditions, allowing for successful establishment in many new areas. It can tolerate salinities ranging from 4 to 33 parts per thousand (Crothers, 1967) and individuals are found in mud, sand and rock substrates, eelgrass beds, and salt marsh habitats. On the west coast, populations of *C. maenas* are restricted primarily to soft-substrate habitats in the high intertidal, salt marshes, and warm sloughs of estuaries and bays (Grosholz et al., 2000). This species can withstand temperatures between 6 and 26°C; however, it cannot breed in continuously warm water (14-26°C) (Crothers, 1967). *C. maenas* is known to be a voracious predator and will consume a wide variety of prey items. In central California, this species has been linked to the declines of native clams *Nutricula tantilla* and *N. confusa*, as well as the shore crab, *Hemigrapsus oregonensis* (Grosholz et al., 2000).

In Bodega Bay, the *C. maenas* population has altered the dynamics of the bay, leading to what Grosholz has described as an ‘invasion meltdown’ (University Of California, 2005). Another invader, the eastern gem clam, *Gemma gemma*, existed in Bodega Bay in small numbers among the abundant *Nutricula spp* prior to arrival of *C. maenas*, which now prefers preying on *Nutricula spp* over *G. gemma* 2 to 1. Direct competition had kept the gem clam population in check for nearly 50 years until the green crab reduced the number of natives, allowing the invasive clam to spread rapidly throughout the bay.

In Humboldt Bay, the first specimens of *C. maenas* were caught by hand on June 24, 1995 on the east side of Arcata Bay. The mode of establishment in Humboldt Bay is unknown; however, green crabs were likely introduced as larvae in ballast water or from natural dispersal from an established population to the south (Miller, 1996). Subsequent sampling efforts in 1996 and 1997 have produced low numbers of the invasive crab. However, in the summer of 1998, the number of *C. maenas* found in west coast bays and estuaries increased local concern for possible impacts in Humboldt Bay. Since 1998, Sea Grant has conducted trapping efforts for the invasive green crab in Humboldt Bay until 2006 when a lack of adequate funding and personnel limited the sampling. In 2008, Department of Fish and Wildlife (CDFW) biologists volunteered to revive the sampling effort in the bay. A report prepared by Susan McBride (2002), of UC
Sea Grant summarizes the trapping efforts between 1998 and 2001, and previous reports by CDFW (Ramey and Weltz 2011, 2012) summarize the trapping efforts conducted from 2002 to 2011. This report is a continuation of those summaries and presents the trapping effort for the 2012 trapping season.

Project Location

Humboldt Bay (N 40° 46’, W 124° 14’) is a marine-dominated, estuarine embayment linked to the Pacific Ocean by a narrow (0.5 mi) entrance channel. Humboldt Bay is one of California’s largest estuaries, covering 24 mi² at mean high water (MHW) and second only to San Francisco Bay, which is located approximately 230 miles to the south. Intertidal mudflats cover 65-70% of the total bay area and extend from MHW to mean low low water (MLLW) over an approximately 6.5 ft relief (Barnhart et al., 1992). Humboldt Bay temperatures range from 48-68°F. Salinities range from 25-34 ppt, with true estuarine conditions occurring only near the mouths of the six tributaries that enter Humboldt Bay.

The bay consists of three regions: North Bay, Entrance Bay, and South Bay. North Bay is farthest from the entrance channel, resulting in a mud-dominated system. Entrance Bay links North Bay to the entrance and contains two islands, Indian Island and Woodley Island. South Bay receives significant sediment from ocean currents resulting in sand and silty substrates in the western portion and soft, muddy substrates in the east. Eelgrass (Zostera marina) forms extensive meadows in North and South Bay, whereas in Entrance Bay, narrow fringing beds occupy the edges of dredged channels with steeply sloping walls. Remnant salt marshes form the perimeter of much of Humboldt Bay.

Methods

Seventeen sites, located along the intertidal area of North and South Humboldt Bay, were sampled between June 21st and September 18th, 2012 (Table 1). Sites encompassed a variety of habitat types, including docks, earthen levees, mudflats, rip-rap, and salt marsh (Figures 1 and 2, Table 1). Due to staff and time constraints, each site was sampled only once during the sampling period.

Trapping was conducted through the use of rectangular, collapsible 0.5 cm mesh traps measuring 61 x 46 x 20 cm. Six traps were placed at each sampling site during low tides and were deployed for approximately 24 hours. Traps were baited with fish scraps or crushed Pacific oysters (Crassostrea gigas) or bay mussels (Mytilus californianus). All green crabs caught were measured (carapace width in millimeters), weighed to the nearest 0.01 g, sexed and frozen for further studies. Native crabs captured were identified to species, measured (carapace width to the nearest 0.1 mm) and released. All fish species caught were identified, measured (total length to the nearest 0.1 mm), and released. All other organisms caught in the traps were identified, enumerated, and released.
Results and Discussion

One green crab, weighing 29 grams and having a carapace width of 59mm, was trapped at the CA Redwoods riprap site in 2012. Catch-per-unit-effort (CPUE) for this crab during the trapping period was 0.01 crabs per trap and it comprised 1% of the total crab catch (Figure 3).

Catch of other crab species included Pacific rock crab (*Romaleon antennarium*), Dungeness crab (*Metacarcinus magister*), red rock crab (*Cancer productus*), yellow shore crab (*Hemigrapsus orgenensis*), and striped shore crab (*Pachygrapsus crassipes*). Of all species of crabs trapped, yellow shore crab comprised the majority at 45% of the total catch and a CPUE of 0.3 crabs per trap (Figure 3). The yellow shore crab was also the only crab species that was trapped at all four habitat types sampled in 2012, though it was most common at riprap sites (Figure 4).

Fish species captured during the 2012 trapping season included Pacific staghorn sculpin (*Leptocottus armatus*), shiner perch (*Cymatogaster aggregate*), and longjaw mudsucker (*Gillichthys mirabilis*).

The size of the current green crab population in Humboldt Bay is not known, nor is it known whether the population will become established in large numbers in the future. Competition with native shore crabs and predation by fish, birds, and larger crabs are likely reasons for the low numbers of *C. maenas* encountered in Humboldt Bay. However, the invasive green crab remains a cause for concern should this species increase in number in the future. It is our intent to continue this yearly monitoring effort in order to alert local fish and wildlife managers if and when numbers increase and impacts from *C. maenas* become significant.

References


Miller, T.W., 1996. First record of the green crab, Carcinus maenas, in Humboldt Bay, California. California Fish and Game 82, 93-96.


Figure 1. 2012 green crab trapping locations in North Bay and respective habitat types.
Figure 2. 2012 green crab trapping locations in South Bay and respective habitat types.
Figure 3. Catch per unit effort (CPUE) and percentage of total crab catch for all species of crab trapped during the 2012 season.
Figure 3. Catch by habitat type for all crabs trapped during the 2012 trapping season.
Table 1. Sampling locations by habitat type for the 2012 field season.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Site</th>
<th>Collection</th>
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<tbody>
<tr>
<td>Dock (n=1)</td>
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<td>Triangle Slough</td>
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<td>Riprap (n=4)</td>
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